

B R E V I O R A

Museum of Comparative Zoology

CAMBRIDGE, MASS.

11 OCTOBER, 1968

NUMBER 299

WHAT IS *LUMBRICUS EISENI* LEVINSEN, 1884 (LUMBRICIDAE, OLIGOCHAETA)?¹

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ABSTRACT. Levinsen's species, *eiseni*, after being in the synonymy of an unrelated form and in three lumbricid genera, is excluded from *Bimastos*, as defined by characters less liable to rapid evolutionary modification than those of the genitalia on which the classical system of the Oligochaeta (Michaelsen, 1900 — Stephenson, 1930) was mainly based. The species, now more adequately characterized, cannot go into any other lumbricid genus because of current ignorance of somatic anatomy in their type species. Relationships suggested by available anatomical data are with *Allolobophora chlorotica* and, less closely, with *Dendrobaena rubida* and *Lumbricus* spp.

As the references below show, no agreement has been reached as to the status of Levinsen's species and as to its generic affiliations. The taxon, like other more or less widely spread lumbricid anthropochores as well as most endemics of the family, never was adequately characterized. Although much less material could be procured than was desired, study of new material has enabled the following contribution toward a solution of the problem.

"*LUMBRICUS EISENI*" Levinsen, 1884

Lumbricus eiseni Levinsen, 1884, Vidensk. Meddel. Naturhist. Forhandl. Copenhagen, (4) 5:311, 241. (Type locality, Deer Garden, Copenhagen. Types, 5, in the Copenhagen Museum.)

Allolobophora (Dendrobaena) eiseni, Friend, 1892, Jour. Linnean Soc. London, (Zool.), 24:302.

Helodrilus (Bimastus) eiseni, Michaelsen, 1900, Das Tierreich, 10:503.

Bimastus eiseni, Friend, 1911, Zoologist, (4) 15:145.

Eisenia parva f. *typica* (part) Pop, 1950, An. Acad. Romane, Sect. Sti. Geol. Geogr. Biol., (A) 1 (9):89.

Eisenia eiseni, Graff, 1953, Regenwürmer Deutschlands, p. 27.

¹ From research financed by the National Science Foundation.

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SPECIMENS EXAMINED

Channel Islands. Herm, under rock above tide mark, June 24, 1925, 1-0-0. G. E. Pickford.

South Africa. Cape Province. Cape Peninsula. Kirstenbosch, rotting stump, October 29, 1925, 5-0-4. Table Mountain, Window Gorge, rotting log at 400 feet, July 30, 1926, 0-0-9. Brockenhurst, Queen's Bower, April 2, 1925, 0-0-1. G. E. Pickford.

INTERCEPTIONS BY U.S. BUREAU OF PLANT QUARANTINE

Eire. From soil with twenty-nine narcissus bulbs and two bundles of lily plants, in baggage on plane, arriving at Boston, June 22, 1964, 0-0-1.

Scotland. From heather plants, in plane, arriving at New York, October 26, 1949, 0-0-1.

Germany. From cabbage, in ships stores on Norwegian M/S Lancing, arriving at Savannah, Georgia, October 29, 1964, 0-0-1.

Portugal. From soil with five azaleas, five ferns, two orchids, in baggage on plane, arriving at Boston, May 21, 1965, 1-0-0.

Azores. From soil with one begonia, in baggage on plane, arriving at Boston, June 18, 1965, 0-0-1.

From roots of plants of *Citrus* sp., in baggage on plane, arriving at Boston, June 18, 1965, 2-0-0.

DESCRIPTION

External characteristics. Segments, 79-112 (cf. Table 1). Color, brown, slate to almost black but never red, restricted to dorsum except in ii-vi or vii, most obvious anterior to the clitellum, usually lacking or very sparse in buccal and anal segments. Body sub-circular in cross section posteriorly. Prostomium, tanylobous (all).

Setae, all present in ii, the *d* setae at or below *mL* anteriorly but posteriorly above that level, *BC* usually $< AA$ throughout post-clitellar region where $DD < \frac{1}{2}C$.

Nephropores, obvious. On one South African worm they are above *B* on the left sides of x-xiii, xv, xvi, xix-xx, xxvi, on the right sides of ix-xi, xv, xxii-xxvi, xxix. Other pores of that worm, in the region of iv-xxix, are well above *D*. Pores of xv-xvi, except on one other worm (left pore of xv not found), were lateral to *B*. Pores may be at the same level on one side for three, four, or five consecutive segments, but on the opposite side asymmetry is occasional. Pores of xii have been seen (rarely) just below *C*. The arrangement throughout most of the axis can be characterized as: irregularly alternating, usually between two levels, one slightly lateral to *B* and another about midway between *D* and *mD*, with occasional intrasegmental asymmetry.

First dorsal pore, at 5/6 (21 specimens), occasionally smaller than the one at 6/7.

Female pores, slightly lateral to *B*, equatorial in xiv. Male pores, minute, at or median to *mBC*, each laterally in a small cleft at eq/xv. Male tumescences, confined to xv and to median half of *BC*.

Clitellum, red (formalin preservation), saddle-shaped, reaching ventrally to or nearly to *A*, or mostly annular, in xxiv-xxxii but restricted to *DD* in xxiv and xxxii (13), xxiv-xxxiii/n (1), xxv-xxxi (2, possibly not fully developed). Even at apparent maximal development the clitellum is thinner in *AA* than laterally and intersegmental furrows still are recognizable ventrally from *mBC*.

Genital tumescences, often conspicuous, without distinct boundaries, transversely elliptical, including *a,b*, in xvi (27), xxiv (2), xxiv-xxv (1), xxv (26).

Internal anatomy. Septa, none thickly muscular, 10/11 bulged anteriorly and 11/12 posteriorly by the calciferous gland, the coelomic cavity of xii, xiii and xiv quite small. Pigment, lacking in peritoneum, present anteriorly in the longitudinal muscle band at *mD* but disappearing behind the clitellum, associated with or in circular muscle layer, apparently brown, yellow brown, or dark brownish red. Pharyngeal glands to 8/9.

Brain, circumpharyngeal connectives and subpharyngeal ganglion all left in iv (19), sometimes well posteriorly, by a transverse section exactly along 3/4.

Ventral bundles of the longitudinal musculature, according to Prof. Harman (*in litt.*), can be characterized as fasciculate, the pinnate arrangement so characteristic of some species of *Lumbricus* being lacking. The cells form compact "Kastchen" ventrally and a compact band dorsally. Ventrally the bundles resemble those of *A. chlorotica*.

Calciferous sacs, in x, elongated horizontally rather than vertically, anteriorly or anterolaterally directed, reaching to or nearly to 9/10, apparently opening posteriorly into gut lumen at level of insertion of 10/11. Calciferous lamellae, extending nearly to anterior end of sac but in x small and of squarish shape. Gut much widened, rather bead-shaped and with vertically slit-like lumen in xi, narrower (half as thick as in xi) and of nearly uniform calibre through xii-xiv. A deep internal constriction (or vertical groove) on one or both sides at or slightly behind insertion of 11/12. Calciferous lamellae, large and rectangular in xi, but behind insertion of 11/12 quite small, not reaching 12/13 (if present posteriorly too small to be recognized in dissections). The inner lining of the gut was rotted away in slightly macerated specimens so as to reveal lamellae with diagrammatic clarity. Intestinal

origin, in xv (20). Gizzard, in xvii (20), the layer with brilliant muscular sheen in horizontal sections narrowing behind insertion of 17/18 and not reaching 17/18. A postgizzard valve, if present, is relaxed in each worm but the gut is somewhat narrowed at 18/19 or in xix. Typhlosole, beginning gradually in region of xx-xxiv, at first a low horizontal band, then becoming vertically and rather thickly lamelliform. A slight longitudinal groove may be recognizable on the ventral face at mV, or, if not, a slight longitudinal flange may be visible on each side. (Condition does not allow a more precise characterization.) The typhlosole ends, abruptly in unamputated specimens, in xc-xevii (Table 1), leaving 8-15 segments (proctodeal?) atyphlosolate.

Dorsal blood vessel, continued onto pharyngeal bulb. Sub-neural, adherent to nerve cord. Extra-oesophageal trunks, median to hearts, posteriorly in xii passing up to dorsal trunk (21). Hearts, present in viii-xi (22). Quite slender vessels at sites (in other species) of hearts of vii were traceable to ventral trunk only in three worms in each of which only the dorsalmost quarter is heart-like.

Nephridia, vesiculate. Bladders, each in shape of a long U-shaped loop, from *A* well into *DD*, both limbs of the loop of about the same length, posterior limb passing into parietes near *B*. The one other major loop is longer than the bladder loop.

Holandric. Testes, flattened horizontal discs sometimes rather fan-shaped or saccular and pyriform. Male funnels, crenellate, large. Male deferent ducts, rather slender, almost straight, slightly sinuous, with several, very short, u-shaped loops, once a single long hairpin-loop, or coiled into a ball, loops or coils up to a millimeter away from funnel septum. Ducts of a side, uniting posteriorly in xii, continued to eq/xv across top of atrial gland (latter developed after penetration of duct into parietes?) or disappearing from sight at edge of gland. Seminal vesicles, rather small to small but not vestigial, vertical or dorsal, soft, without obvious lobing, in xi-xii (15). Anterior vesicles, flattened in the space between septum 10/11 and the anterior face of the calciferous gland.

Ovaries, often large and then reaching up to level of dorsal face of gut, filled except in proximal quarter or so with large ova, each with a single egg string containing one to three ova. Ovisacs, with one to five ova which were easily released by teasing, especially those in a distal portion. Oviducts, rather thick passing into parietes lateral to *D*.

Atrial glands (14 clitellate worms), confined to median portion of *BC* or reaching nearly to *C*, flat or of a rather low dome-shape, usually with a cleft at eq/xv and another at insertion of 15/16,

reaching to or well toward 16/17. TP glands, lacking (all). GS follicles, large, conspicuously protuberant into coelomic cavities, genital setae elongated and otherwise modified. Follicles of ventral couple of xv not as much enlarged as the others. Supraparietal glands around GS follicles, lacking (all). Follicles of all ventral couples, from the clitellum anteriorly, larger than those of the lateral setae.

Variant specimen. Clitellum, light pink rather than red, reaching little below C, but of near maximal thickness in region of mD except at intersegmental furrows which are still obvious even there. Male funnels, smaller than usual but crenellate, with very slight iridescence. Male deferent ducts pass into parietes at eq/xv. Atrial glands lacking (no rudiments recognizable in longitudinal musculature). GS follicles smaller than usual. Distal two-thirds of ovaries with apparently mature ova. No ova in ovisacs.

The clitellum probably had not attained full development. Absence of atrial glands does not, however, appear to be attributable to immaturity. Hence the worm may be of a strain (possibly with obligatory parthenogenesis and markedly reduced spermatogenesis) in which the atrial glands already have been lost and in which genital setae as well as tumescences are disappearing. Elimination of genital tumescences and genital setae would result in a state similar to that of *Bimastos* species.

Reproduction. Spermatophores were present externally in clitellar region of two worms but no iridescence was recognized in the opaque matter within the transparent cases. Spermatozoal iridescence was lacking on funnels of one worm but on those of other clitellate worms does not seem to be as brilliant as in species with obligatory cross-breeding, and was not recognized in male deferent ducts. Sparse maturation of sperm is associated, in some lumbricids, with parthenogenesis. Pyriform testes are unusually soft, much of the interior filled with a watery fluid in which there are many morulae but only a very few sperm. Uniparental reproduction has been demonstrated for this species by Evans and Guild (1948).

Bimastos eiseni is diploid, $2n = 32$, according to Muldal (1952:61). Parthenogenesis is not, however, contraindicated by the diploidy, that method of uniparental reproduction being obligatory (*idem*:66) in diploid individuals of *Octolasion tyrtaeum* (Örley, 1881).

Remarks. Soil particles of any sort were completely absent from guts of each of these worms, the lumen being filled with brown organic matter.

Distribution. Ireland, Scotland, England, Channel Islands, Sweden, Denmark, Germany, Poland, Belgium, Czechoslovakia, France, Switzerland, Austria, Italy (including Sicily), Yugoslavia, Albania, Bulgaria, Portugal.

Azores, Madeira, Canary Islands, South Africa, St. Helena, India (Western Himalayas only), New Zealand (including Stewart Island).

The extra-European records show that the species has been frequently transported by man with many successful colonizations. Absence from the Americas where so many other lumbricid anthrochorens are well established is puzzling. In Europe, presence above the southern limit of Quaternary glaciation may also be a result of unintentional human carriage. The original home of the species is unknown. It must have been somewhere in Eurasia but how much of the distribution in southern Europe is fortuitous, remains to be learned.

The species has been called cosmopolitan (Omodeo, 1950:5) and Euro-American (Omodeo, 1961, table). The first adjective hardly seems applicable to a species absent from all Americas, most of Africa and all of Asia except for a couple of localities in the western Himalayas. The second characterization is inapplicable.

Systematic relationships. The clitellum is shorter posteriorly than in English definitions (Cernosvitov and Evans, 1947; Gerard, 1964). Paucity of data about individual variation in *eiseni* at present obviates further discussion of the differences.

The species does not belong in *Bimastos* as that genus now (Gates, in press) is defined. The calciferous sacs of segment x suggest relationships with *Lumbricus*, *Dendrobaena rubida* and related species (but certainly not *D. octaedra* and related species), as well as *Allolobophora chlorotica*. Further evidence is provided by the similarity, in each taxon, of nephridial vesicles and nephropore locations. Many characters provided by those and other somatic systems now seem resistant to rapid evolutionary modification and so are of greater systematic importance than the more easily changed genitalia on which classical specialists so much relied.

The purple red pigment by which *Dendrobaena*, *Eisenia* and *Lumbricus* were defined (Pop, 1941) is lacking in *chlorotica* and *eiseni*. The longitudinal musculature of *Lumbricus* spp. and of *D. rubida* (also closely related species?) is pinnate in cross-section rather than fasciculate as in *eiseni* and *chlorotica*. Atrial glands (ignored by classical authorities) are indeed present in *D. rubida*.

and related species just as in *eiseni* and *chlorotica* but are lacking in all species of *Lumbricus* studied by the author. Those differences seem to suggest that *chlorotica* and *eiseni* may be more closely related to each other than either is to any of the other above-mentioned taxa.

Then, should *eiseni* be transferred to *Allolobophora* of which *chlorotica* recently was made the type species? If the two species do belong in the same genus, that is where *eiseni* seemingly should go. *A. chlorotica*, however, differs from every one of the common allolobophoras by its calciferous sacs, by the presence of well developed atrial glands (lacking in every one of the common allolobophoras), as well as by other characters. Information now available indicates that: 1) *Enterion chloroticum* Savigny, 1826, should not have been designated the type of *Allolobophora*. 2) All of the common allolobophoras, if that type designation in some way cannot be nullified, must go into another and possibly new genus.

The common species of the classical *Allolobophora* are now widely distributed throughout much of the world. They successfully colonized many areas to which they were introduced and even now are spreading, and being spread both accidentally and deliberately, through considerable areas of Australia and New Zealand. Those same species also have been widely used in experiments. *A. chlorotica* and *B. eiseni*, on the contrary, were much less often transported, have not colonized so extensively, are much less common, and only rarely have been studied experimentally.

Attention was directed on two previous occasions (Gates, 1958a, b) to the fact that *eiseni* does not belong in the American genus *Bimastos*, primarily in the hope that some interest in the problem would thereby be aroused on the part of those who have access to more plentiful material. Because of our ignorance of so much essential data for a large majority of lumbricid species, no nomenclatural changes are made herein.

The single North American anthropochore, *Bimastos parvus* (Eisen, 1874), is not of the same genus as *eiseni* and just as obviously does not belong in *Eisenia*. What *Eisenia parva* of sundry authors was, probably can only be determined from an examination of the specimens.

Parasites. Nematodes from coelomic cavities of the Scotch worm, according to Dr. S. Prudhoe of the British Museum, probably are *Dicelis filaria* Dujardin 1845. Nematodes from the ventral blood vessel in x-xiv of a Channel Islands juvenile were identified by Dr. Maybelle Chitwood as larvae of *Spiroptera turdi* Molin by Cori, 1898.

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(Received 16 January 1968.)

TABLE 1
Typhlosole termination and segment number
in "*Lumbricus eiseni*"

Serial Number	Typhlosole ends in	Atyphlo- solate segments	Number of Segments	Remarks
1	70	9	79	Posterior amputee*
2	74	7	81	Posterior amputee*
3	82-85	3	88	Posterior amputee*
4	80-86		86	Posterior amputee*
5	88	11	99	Channel Islands
6	90	9	99	
7	90	13	103	
8	91	13	104	
9	92	9	101	
10	92	12	104	Posterior amputee*
11	92	15	107	
12	93	12	105	
13	95	8	103	Posterior amputee*
14	96	13	109	
15	97	15	112	

Specimens from South Africa unless otherwise indicated.

* After loss of the posterior end, the presently terminal metamere had been reorganized and now looks much like a normal anal segment. Proof of its original, preterminal position is provided by vestiges of former apertures of setal follicles. The latter were lysed after dehiscence of their setae.